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CAPRI

Computational Analysis PPrograming Interface

A Solid Modeling Based Infra-structure for
Engineering Analysis and Design Simulations

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ABSTRACT

Authored By
Robert Haimes
Massachusetts Institute of Technology
haimes@orville.mit.edu

Gregory J. Follen
NASA Lewis Research Center
gfollen@lerc.nasa.gov

CAPRI is a CAD-vendor neutral application programming interface designed for the construction of analysis and design systems. By allowing access to the geometry from within all modules (grid generators, solvers and post-processors) such tasks as meshing on the actual surfaces, node enrichment by solvers and defining which mesh faces are boundaries (for the solver and visualization system) become simpler. The overall reliance on file 'standards' is minimized.

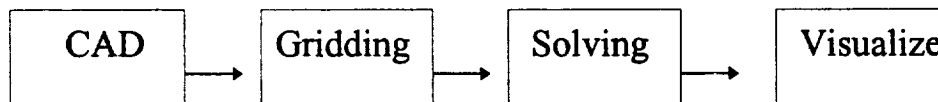
This 'Geometry Centric' approach makes multi-physics (multi-disciplinary) analysis codes much easier to build. By using the shared (coupled) surface as the foundation, CAPRI provides a single call to interpolate grid-node based data from the surface discretization in one volume to another. Finally, design systems are possible where the results can be brought back into the CAD system (and therefore manufactured) because all geometry construction and modification are performed using the CAD system's geometry kernel.

Herein, lies the need for such a system as CAPRI. The NASA Lewis Research is building the Numerical Propulsion System Simulation(NPSS) which has a vision of creating a "numerical test cell" that enables full engine simulations overnight on cost effective computing platforms. NPSS accomplishes this vision by integrating multiple disciplines such as aerodynamics, structures and heat transfer with computing and communication technologies to capture complex physical processes in a timely and cost effective manner. NPSS is pursuing its concepts in numerical zooming and multi-disciplinary coupling of codes in developing the NPSS Environment and Architecture. In order to conduct complex multi-discipline simulations overnight, solving the problem of providing common geometry representations or common access across all pieces of

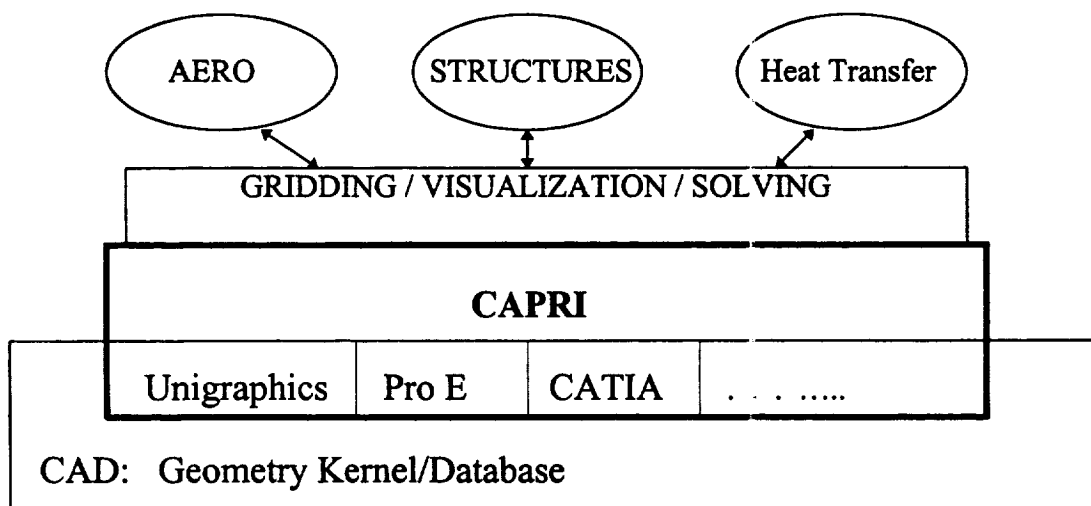
the simulation or design space is required. CAPRI offers a solution to this real world dilemma which is comprised of multi-vendor, differing need companies that require access to geometry which preserves all the inherent features of that geometry while allowing each discipline the ability to register its effect to the geometry in a way for all other subject disciplines to see.

The computational steps traditionally taken for Computational Fluid Dynamics (CFD), Structural Analysis, and other simulation disciplines (or when these are used in design) are:

- Surface Generation
- Grid Generation
- Flow Solver or Simulation
- Post-processing Visualization



Instead of the serial approach to analysis as described above, CAPRI uses a geometry centric approach. This makes the actual geometry (not a discretized version) accessible to all phases of the analysis. The connection to the geometry is made through an Application Programming Interface (API) and NOT a file system. This API isolates the top level applications (grid generators, solvers and visualization components) from the geometry engine. Also this allows the replacement of one geometry kernel with another, without effecting the top level applications. For example, if UniGraphics is used as the CAD package then Parasolid (UG's geometry engine) can be used for all geometric queries so that no solid geometry information is lost in a translation. If Pro/E is used then Pro/Toolkit is accessed when geometric information is required. Pictorially, this is represented by the following figure.



It is very important to consider the design goals when building a new software

architecture. Without properly setting a broad foundation, the system may not be able to function as desired. The goals for CAPRI are:

Modular

The system must support a modular or building-block method for construction. This facilitates a plug and play approach at the top level as well as the underlying geometry kernel.

Multiple languages

It is important to support FORTRAN, C and C++. Many CFD codes are currently written in FORTRAN. On many machines, the FORTRAN compiler produces more highly optimized code, giving much better performance. Forcing the core of these algorithms to another language, just because the rest of the system is in that language, is not be part of the philosophy found in CAPRI.

Transient solutions

This system must support unsteady simulations as well as steady-state, which include the underlying geometry changing with time.

Multi-discipline coupling and zooming

This system must be general enough to allow coupling from codes of other disciplines (including but not limited to -- structural analysis, heat transfer, acoustic codes). In fact the coupling could be close, in that the analysis code could be made a part of the overall design system.

Summary

CAPRI is a CAD-vendor neutral application programming interface designed for the construction of analysis suites and design systems. The NASA Lewis Research Center's NPSS project intends to explore CAPRI as a means of coupling multi-discipline and zooming based simulations. This paper will discuss current progress on developing the CAPRI system.

